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**High-Performance Corrosion-Resistant Iron-Based Amorphous Metals: The Effects of Composition, Structure and Environment on Corrosion Resistance**

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**Abstract**

New corrosion-resistant, iron-based amorphous metals have been identified from published data or developed through combinatorial synthesis, and tested to determine their relative thermal phase stability, microstructure, mechanical properties, damage tolerance, and corrosion resistance. Some alloy additions are known to promote glass formation and to lower the critical cooling rate [F. Guo, S. J. Poon, Applied Physics Letters, 83 (13) 2575-2577, 2003]. Other elements are known to enhance the corrosion resistance of conventional stainless steels and nickel-based alloys [A. I. Asphahani, Materials Performance, Vol. 19, No. 12, pp. 33-43, 1980] and have been found to provide similar benefits to iron-based amorphous metals.

Many of these materials can be cast as relatively thick ingots, or applied as coatings with advanced thermal spray technology. A wide variety of thermal spray processes have been developed by industry, and can be used to apply these new materials as coatings. Any of these can be used for the deposition of the formulations discussed here, with varying degrees of residual porosity and crystalline structure. Thick protective coatings have now been made that are fully dense and completely amorphous in the as-sprayed condition.

An overview of the High-Performance Corrosion Resistant Materials (HPCRM) Project will be given, with particular emphasis on the corrosion resistance of several different types of iron-based amorphous metals in various environments of interest. The salt fog test has been used to compare the performance of various wrought alloys, melt-spun ribbons, arc-melted drop-cast ingots, and thermal-spray coatings for their susceptibility to corrosion in marine environments. Electrochemical tests have also been performed in seawater. Spontaneous breakdown of the passive film and localized corrosion require that the open-circuit corrosion potential exceed the critical potential. The resistance to localized corrosion in seawater has been quantified through measurement of the open-circuit corrosion potential ( $E_{\text{corr}}$ ), the breakdown potential ( $E_{\text{crit}}$ ) and the repassivation potential ( $E_{\text{rp}}$ ). The greater the difference between the open-circuit corrosion potential and the repassivation potential ( $\Delta E$ ), the more resistant a material is to modes of localized corrosion such as pitting and crevice corrosion. Cyclic polarization (CP) was used as a means of measuring the critical potential ( $E_{\text{crit}}$ ) relative to the open-circuit corrosion potential ( $E_{\text{corr}}$ ). Linear polarization (LP) has been used to determine the corrosion current ( $i_{\text{corr}}$ ) and the corresponding corrosion rate. Other aspects of the materials will also be discussed, as well as potential applications.

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### **Note**

Authorship reflects multi-institutional collaboration. Additional authors may be added in future revisions of the abstract and paper.